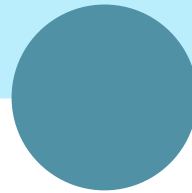
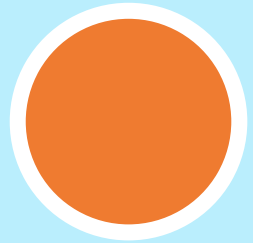


AIS Data Management

Matthew Smith

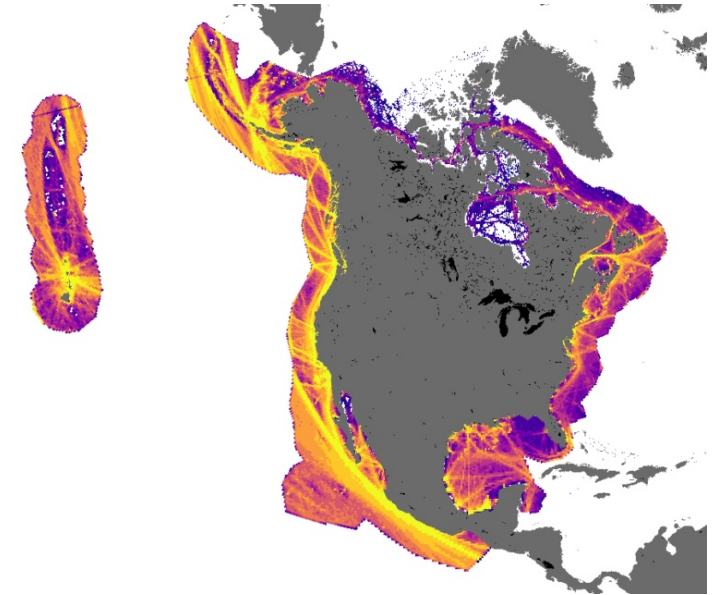
MERIDIAN
Dalhousie University, Halifax, Canada



What is AIS?



- AIS: Automatic Identification System
- Radio frequency communications transmitted by seafaring vessels
- Broadcasts vessel information such as position, direction, and speed



AIS data sample intensity plot.
Credit: Casey Hilliard

Primary Uses



- Collision avoidance
- Traffic management
- Search and rescue

Research Application



- Investigating vessel strikes on whales (Chris Taggart, Meg Carr – Dalhousie Oceanography)
- Informing policy decisions for marine safety, traffic, and conservation (Andrea Nездoly et. al., UVIC GIS lab)
- Tracking spread of invasive species in Canadian waters (Claudio DiBacco et. al., DFO)
- Probably many more...

Example



- Potential impacts of shipping noise on marine mammals in the western Canadian Arctic
Marine Pollution Bulletin 123, p.73-82 (2017)

William D. Halliday, Stephen J. Insley, R. Casey Hilliard, Tyler de Jong, Matthew K. Pine

- “Urgent need to assess impacts of shipping in the arctic before major increases in noise levels occur”
- DFO lists noise as greatest threat to bowhead whales; necessitates lower vessel speeds, alternate routes
- No current legislation in place

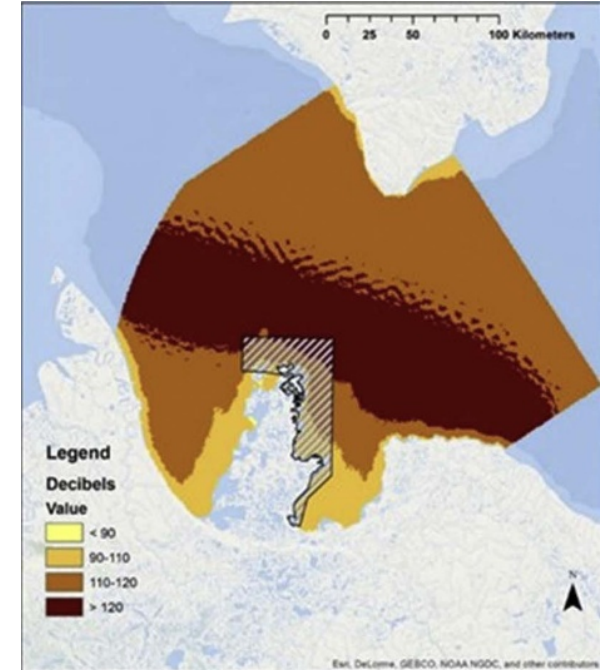
Example



- Potential impacts of shipping noise on marine mammals in the western Canadian Arctic
Marine Pollution Bulletin 123, p.73-82 (2017)

William D. Halliday, Stephen J. Insley, R. Casey Hilliard,
Tyler de Jong, Matthew K. Pine

- AIS tracks coupled with hydrophones to assess arctic noise
- Acoustic models determine mean propagation distances based on observations
- Areas where sound exceeds levels known to influence mammal behaviour are mapped



Credit: *ibid.*; Esri, DeLorme, GEBCO, NOAA NGDC, and others

AIS Data Collection



- Data comes from ExactEarth
- Collected by terrestrial and satellite receivers
- Aggregated in Postgres SQL database built by Casey Hilliard



???



Database Info



- MEOPAR satellite dataset
 - ~7 TB raw SQL data
 - ~1.3TB of indexes and metadata
 - Contains global data from 2011 until one month ago
- MERIDIAN terrestrial dataset
 - Contains detections from ground-based receivers positioned on atlantic coast
- Leverages PostGIS spatial processing library for queries

Visualizing AIS Data



AIS Message Types



- AIS devices have transmitter and receiver capability
- Class A
 - Broadcasted every 2 - 10 seconds while underway, 3 minutes at anchor
 - Transmits at 12.5 watts (long range)
 - Message types: 1, 2, 3, 5, 27
- Class B
 - Awaits available time slot to broadcast – lower priority than Class A
 - Self-organizing (SO) and carrier-sense (CS) subclasses
 - Transmits at 2 watts (short range; 10-16km)
 - Message types: 18, 19, 24



Class A – Messages 1,2,3

- Contains voyage info
- MMSI: unique ship identifier
- ROT: rate of turn
- SOG: speed over ground
- COG: course over ground

```
ee_ais=#
ee_ais=# select * from ais_s_202008_msg_1_2_3 limit 3;
ee_ais=# select * from ais_s_202008_msg_1_2_3 limit 1;
-[ RECORD 1 ]-----+-----
unq_id_prefix      | SE20200801
lineno             | 366739
errorflag          | f
mmsi               | 232013524
message_id         | 1
repeat_indicator   | 0
time               | 2020-08-01 15:26:45
millisecond         | 710
region             | 66
country            |
base_station       |
online_data        |
group_code         |
sequence_id        |
channel            |
data_length        | [28]
navigational_status | 0
rot                | 0
sog                | 16.4
accuracy           | f
longitude          | -179.508433333
latitude           | -37.2666516667
cog                | 90.5
heading            | 92
maneuver           | 0
raim_flag          | f
communication_state | 2242
utc_second         | 44
spare              | 0
ais_geom           | 0101000020E6100000CD2DFB15457066C040F34DA421A242C0
```

```
ee_ais=#
BIGDATA1 47 days % 0:getdata.sh- 1:zsh 2:python 3:postgres* 16:42:05 2020-09-29
```

Class A – Message 5



- Additional voyage info
- Fields such as ship_type are encoded as integers
- Type 30 describes fishing vessels

```
-[ RECORD 1 ]-----+-----  
unq_id_prefix | SE20200801  
lineno        | 102  
errorflag     | f  
mmsi          | 366839630  
message_id    | 5  
repeat_indicator | 0  
time          | 2020-08-01 08:15:01  
millisecond   | 730  
region        | 66  
country       |  
base_station  |  
online_data   |  
group_code    |  
sequence_id   | 8  
channel       |  
data_length   | [56, 15]  
vessel_name   | WESTERLY  
call_sign     | WDA7098  
imo           | 885545100  
ship_type     | 30  
dim_bow       | 25  
dim_stern     | 3  
dim_port      | 4  
dim_star      | 4  
draught       | 30  
destination   | PETERSBURG  
ais_version   | 1  
fixing_device | 1  
trans_control |  
eta_month     | 5  
eta_day       | 22  
eta_hour      | 8  
eta_minute    | 0  
sequence      |  
:
```

BIGDATA1 47 days % 0:getdata.sh- 1:zsh 2:python 3:postgres*

16:43:15 2020-09-29



Class A – Message 27

- Compressed version of messages 1,2,3 for long range detection
- Timestamp is provided by receiver
- ais_geom: column generated during preprocessing - used for spatial queries

```
ee_ais=#
ee_ais=#
ee_ais=#
ee_ais=# select * from ais_s_202008_msg_27 limit 1;
-[ RECORD 1 ]-----+-----
unq_id_prefix      | SE20200801
lineno             | 22
errorflag          | f
mmsi               | 257048700
message_id         | 27
repeat_indicator   | 3
time               | 2020-08-01 23:59:00
millisecond        | 710
region             | 66
country            |
base_station       |
online_data        |
group_code         |
sequence_id        |
channel            |
data_length        | [16]
navigational_status | 0
sog                | 0
accuracy           | t
longitude          | 16.5466666667
latitude           | 68.7833333333
cog                |
raim_flag          | t
gnss_status        | f
spare              | 0
ais_geom           | 0101000020E6100000324ABF58F28B3040F918222222325140

ee_ais=#
ee_ais=#
ee_ais=#
ee_ais=#
BIGDATA1 47 days % 0:getdata.sh- 1:zsh 2:python 3:postgres* 16:47:49 2020-09-29
```



Class B – Message 18, 19

- Contains AIS device metadata
- e.g. unit flag: self-organizing or carrier-sense (boolean)
- Msg19 is a more detailed version of 18 used by certain devices

```
-[ RECORD 1 ]-----+-----  
uniq_id_prefix | SE20200801  
lineno         | 24  
errorflag      | f  
mmsi           | 576843000  
message_id     | 18  
repeat_indicator | 0  
time           | 2020-08-01 23:59:36  
millisecond    | 620  
region         | 66  
country        |  
base_station   |  
online_data    |  
group_code     |  
sequence_id    |  
channel        |  
data_length    | [28]  
sog            | 5.4  
accuracy       | t  
longitude      | -145.522741667  
latitude       | -34.5655616667  
cog            | 215.7  
heading        |  
utc_second     | 34  
unit_flag      | t  
display        | t  
dsc            | f  
band           | t  
msg22         | f  
mode           | 0  
raim_flag      | f  
communication_flag | t  
communication_state | 393222  
:  
BIGDATA1 49 days % 0:getdata.sh- 1:zsh 2:python 3:postgres* 14:28:31 2020-10-01
```



Class B – Message 24

- Contains ship metadata
- Can be used to associate vessel identifier with a name
- Should be transmitted at least once every 6 minutes

```
ee_ais=# select * from ais_s_202008_msg_24 where ship_type = 35 limit 1;
-[ RECORD 1 ]-----+-----
unq_id_prefix | SE20200801
lineno        | 24383
errorflag     | f
mmsi          | 710119772
message_id    | 24
repeat_indicator | 0
time          | 2020-08-01 10:19:47
millisecond   | 138
region        | 66
country       |
base_station  |
online_data   |
group_code    |
sequence_id   |
channel       |
data_length   | [28]
vessel_name   |
call_sign     | 100200
imo           |
ship_type     | 35
dim_bow       | 10
dim_stern     | 9
dim_port      | 8
dim_star      | 7
fixing_device |
part_number   | t
vendor_id     | SHANWEI
mother_ship_mmsi |
spare         | 0
```

```
ee_ais=#
BIGDATA1 49 days % 0:getdata.sh- 1:zsh 2:python 3:postgres* 15:09:49 2020-10-01
```

Acknowledgement



- Oliver Kirsebom
- Casey Hilliard

Reference



- Potential impacts of shipping noise on marine mammals in the western Canadian Arctic
Marine Pollution Bulletin 123, p.73-82 (2017)
William D. Halliday, Stephen J. Insley, R. Casey Hilliard, Tyler de Jong, Matthew K. Pine
- US Coast Guard <https://navcen.uscg.gov/>
- Satellite AIS for Dummies – Heather Ball

Data Access



- Will AIS data benefit your research?
- For access and inquiries:
 - <https://meridian.cs.dal.ca/vessel-tracking-data/>
 - matthew.smith@dal.ca
- Questions?